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An overview of new types of bread Smart and active packaging and future prospects

Authors (Times New Roman, Font size 44, Italic)

Background and Aims: Bread, a global staple, is prone to quality and shelf-life issues due to physical, chemical, and microbiological changes. These challenges include staling and microbial spoilage, which can produce harmful mycotoxins. To improve safety and longevity and reduce annual waste, the baking industry is exploring traditional methods alongside new solutions like active and intelligent packaging.

Materials and Methods: This review article aims to analyze recent innovations in bread packaging through a comprehensive search of scientific literature and relevant keywords over the past decade, culminating in a synthesis of the findings. Reviewing articles published in the last ten years (2013-2023)

Results: **Microbial** spoilage of bread leads to significant economic losses in the baking industry. Active food packaging systems help preserve quality, delay microbial growth, and extend shelf life, with a growing focus on natural materials. Smart packaging can sense environmental changes and includes external indicators (like temperature monitors), internal indicators (like oxygen sensors), and information-enhancing devices (like barcodes). The terms "smart packaging" (sensing and communication) and "ultra-smart packaging" (combining smart and active features) are often used interchangeably.

Conclusion: Intelligent and active packaging can significantly enhance bread's shelf life and quality. With further advancements and reduced production costs, these technologies are expected to see wider adoption in the baking industry, improving consumer experiences.

References: 1. Hempel, A. W., O'Sullivan, M. G., Papkovsky, D. B., & Kerry, J. P. (2013). Use of smart packaging technologies for monitoring and extending the shelf-life quality of modified atmosphere packaged (MAP) bread: Application of intelligent oxygen sensors and active ethanol emitters. *European Food Research and Technology*, 237, 117-124.
2. Pasqualone, A. (2019). Bread packaging: Features and functions. In *Flour and breads and their fortification in health and disease prevention* (pp. 211-222). Academic Press.